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ABSTRACT

The purpose of this study is to describe the assessment environment in constructivist-oriented science, technology, and society (STS) classrooms. Data were gathered from in-depth interviews and subjected to a constant comparative analysis associated with a grounded theory model. Three themes emerged from the analysis: (1) a description of the assessment environment; (2) the variety of assessments used by teachers; and (3) the use of higher order thinking skills in assessments. Implications for pre-service teaching include the development of inclusion of constructivist assessment practices in science courses, the observation of classrooms where constructivist assessment practices are currently in use, and further exploration of various types of assessments. The research design uses the goals and tenets of the Iowa Scope, Sequence, and Coordination (SS&C) project and draws on the ideas of active learning, prior knowledge, and learner responsibility. Contains 58 references. (Author/DDR)

Constructivist Assessment Practices

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Abstract

The purpose of this study was to describe the assessment environment in constructivist/ STS science teachers classrooms. This was accomplished by in-depth interviews that were subjected to a constant comparative analysis associated with a grounded theory model. Three themes emerged from the analysis, a description of the assessment environment, the variety of assessments used by teachers, and the use of higher order thinking skills in classroom assessments. Implications for pre-service teaching include the development of the inclusion of constructivist assessment practices in science courses, the observation of classrooms where constructivist assessment practices are currently in use, and deeper exploration of various types of assessments.

Introduction

What kinds of assessments do teachers use in traditional and reform classrooms to determine a student's grade? If assessments evolve out of instruction, as is expected in inquiry and constructivist-based classrooms, then assessments should reflect what students learn and can do. There is a problem with investigating classroom assessment strategies because teachers' beliefs, practices, and other factors cause teachers to use many different formal and informal assessments (Airasian, 1994; Angelo & Cross, 1993; Penick & Bonnstetter, 1993; Smith, 1979; Smith, 1993) . There is abundant research on the variety and diversity of assessments used by teachers (Airasian, 1994; Angelo & Cross, 1993; Brownstein, 1996; Champagne, 1992; Council, 1996; Doran, 1990; Harrison, 1996; Hart, 1994; O'Sullivan & Chalnick, 1991; Wiggins, 1989) . There is little research on what actually happens between teacher and student in terms of assessments undertaken in classrooms (Shepard, 1989; Stiggins, 1991a; Stiggins, 1985; Stiggins, Conklin & Bridgeford, 1986; Watson, 1995; Briscoe, 1994; Tobias, 1992; Stiggins & Conklin, 1992).

The purpose of this study was to describe, not prescribe, the assessment environment as it pertains to constructivist assessment practices presented in Iowa Scope, Sequence, & Coordination (Iowa SS&C) and other Iowa science classrooms (IST).

Theoretical Framework

This study used constructivist theory and the goals and tenets of the Iowa SS&C project as its framework. Three constructs emerge from the literature regarding constructivism and have implications for the learning environment. They are (1) learning is an active process, (2) the learner has prior knowledge, and (3) the learner takes responsibility for their own learning (Yager, 1991; Cobb et al 1992, Magoon, 1977; Hewson & Hewson, 1988). These three ideas are central to this study. These ideas can be operationalized by the following statements.

- Assessments are in a meaningful context that is relevant or has emerging relevance to students (Brooks & Brooks, 1993) .
- The process of learning does not shut down during assessment (Brooks & Brooks, 1993) .
- Formal assessments are tailored to specific modules and teaching situations (Zahorik, 1995) .
- Assessments include higher order thinking skills, i.e., application, evaluation, analysis, synthesis (Burry-Stock, 1995; Yager, 1991) .
- Assessments include application of knowledge and comprehension (Zahorik, 1995) .
- A range of techniques is used in assessments (Burry-Stock, 1995; Zahorik, 1995) .
- Assessments focus on the big pictures on concepts and on issues and their accompanying facts and evidence (Zahorik, 1995) .
- Assessment includes inquiry (Brooks & Brooks, 1993; Yager, 1991).
- Students go beyond initial information levels (knowledge and comprehension) through elaboration doing in-depth analysis of big ideas, issues and concepts (Brooks & Brooks, 1993) .
- Students solve problems in which they extend and re-conceptualize (accommodation) knowledge in new contexts (Brooks & Brooks, 1993; Osborne & Wittrock, 1983; Zahorik, 1995) .
- Students generalize (synthesis) experiences from earlier concrete experiences a to understand abstract theories and applications (Brooks & Brooks, 1993; Osborne & Wittrock, 1983; Zahorik, 1995) .
- Students exhibit knowledge through application (Yager, 1991) .
- Students interact with each other in all circumstances including during assessments (Zahorik, 1995) .

Methods

Participants

The participants that contributed information for this portion of the study were a sub-sample of a larger study group (Freedman, 1997; Marshall & Rossman, 1995) . Potential candidates were defined by the parameters of the larger study. Nine teachers from the Iowa SS&C sample and eight teachers from the IST sample agreed to participate in this section of the study. The sample, n=17, included 9 females (5 in Iowa SS&C, 4 in IST) and 8 males (4 in Iowa SS&C and 4 in IST). There were 7 middle school teachers (4 in Iowa SS&C, 3 in IST) and 10 high school teachers (5 in each). Teaching experience ranged from 4 to 36 years with 19.3 years being the average.

Data Collection

The interview format was chosen for its adaptability (Cates, 1985; Gall, Borg & Gall, 1996) . The interviews used in this study were semi-structured and contained four main questions (Gall et al., 1996) . Interview questions included:

1. Please explain or describe how your assessment/grading items were used to grade your students.
2. Which assessments/grading items intrinsically motivated your students?
3. What is the relationship between your assessment/grading practices and beliefs about good assessment/grading?
4. What people, courses, programs, etc., have influenced the way you assess/grade your students?

Data Analysis

A pilot interview with one Iowa SS&C middle school teacher was used to define the initial interview questions derived from Iowa SS&C tenets and specific constructivist assessment behaviors (Yager & Tamir, 1993; Yager, 1991; Zahorik, 1995) . Questions were asked of the interviewees in a semi-structured manner. An interview protocol was used. Two interviewees, one middle school and one high school, were chosen to act as key informants. The two were picked on the basis of their known expertise as expert constructivist/STS approach teachers (Yukatom, 1997; Varrella, 1997).

The constant comparative method following a grounded theory model was followed for analysis of the interviews (Marshall & Rossman, 1995; Miles & Huberman, 1994) . The information gleaned from this phase was used to answer the implied 'Why' in the research question, "How is participation in a reform project a predictor for constructivist assessment practices?" In this study the multi-case sub-sample of teachers added to the generalizability of the study (Gall et al., 1996) .

Interviews were recorded and transcribed. HyperResearch® (Version 1.65) was used to facilitate the *unitizing* of data from each interview (Marshall & Rossman, 1995) . After coding was completed, refinement of categories occurred (Marshall & Rossman, 1995) . Finally the *rules of inclusion* and accompanying text were examined for connections and emerging themes. Data synthesis was checked with an independent researcher to add to the trustworthiness of the analysis. Three themes emerged: a description of the assessment environment, a variety of assessments are used to make up students' grades, and the usage of higher order thinking processes during assessment.

Findings and Discussion

The Assessment Environment

In the assessment environment teachers take on the role of facilitator (Harms & Yager, 1981) . The assessment environment has two major sub-divisions, what defines the environment, and what influences the environment. The defining elements of the assessment environment are (a) teacher beliefs, (b) teacher practices, and (c) how teachers engage students in the social context in which assessment and instruction takes place. Influences on the environment are both internal and external.

Defining the Environment Through Teacher's Beliefs

Teachers are guided in their assessment practices by their beliefs. Three beliefs were identified by teachers that guide their practices in a constructivist classroom. They were: (a) teachers need to change, (b) *doing* and thinking about science is more important than being able to recite facts, (c) students can be responsible for their own assessment and learning.

The first belief is that teachers believe they need to change in order to create assessments that meet the changing needs of all students.

They do this by changing their perspective.

> And then I started changing and once you start changing, the more you change the more you want to change. And so it becomes almost a passion to take it to another level every year and hopefully meet the needs of every kid that you teach.

They do this by exploring new avenues.

> The most difficult task I have as a teacher is to be sure that at times I teach out of my comfort zone, that I try to learn the needs of all learners and that's also the reason that I think a wide variety of assessment strategies need to be incorporated.

They do this by infusing new information into their classes.

> Infusing technology is another one that you have to constantly have to keep up with that. They're always coming out with something new. So I've got to keep going.

In order for change to occur teachers need to accept it (Fullan, 1996; Fullan & Hargreaves, 1991) . Teacher beliefs affect their practices (Varrella, 1997) . Iowa science teachers accept change. The second belief is that *doing* science is more important than being able to recite facts.

> Number one if we're doing things that they're interested in and I'm still getting the kinds of things covered that I feel are necessary or at least the practices that are being covered, if they know how to manipulate things, if they know how to ask good questions, if they know how to find information, if they know how to write a good paper. That's more important than whether or not they know what constellation is going to be in the night sky tomorrow night.

Teachers believe that skills and attitude are important (Harms & Yager, 1981) . They believe in doing science through inquiry (Yager, 1991) . They believe that less is more (NSES, 1996). In the previous quote, the underlined sections contain the heart of the NSES definition of what it means to be scientifically literate (NSES, 1996; Rutherford & Ahlgren, 1990) . The third belief, is that students can be responsible for their own assessment and learning. They have to be offered an opportunity and an environment where they feel safe to take on responsibilities. Iowa SS&C Goal 3 states that student growth should be improved in terms of attitudes about science, science classes, science teachers and careers. Tenet 7 states that students should work toward quality of thought and understanding (Yager, 1993) . These beliefs are supporting an environment where students feel comfortable in taking an active role.

Defining the Environment Through Teacher's Practices

In addition to beliefs, teachers follow a number of practices that add breath to the assessment environment. They include (a) teachers do not feel restricted to text-embedded assessments, (b) teachers ask for student input, (c) teachers use questioning strategies to assess students' prior knowledge, (d) teachers incorporate knowledge of a larger picture into assessment and instruction, and (e) teachers use a variety of inquiries.

Teachers do not feel restricted to text-embedded assessments that come with texts. They change and modify existing assessments based on perceived student needs and abilities, personal goals, and district policy.

> I try to understand what it is that they're trying to get at and then adjust the assessment so that it really reflects what they've done and that there isn't some kind of an artificial thing there that has a built in thing that they're always going to be successful or it's so structured that they can't possible do well. So as long as we have some kind of agreement before we start, that these are the things that are reasonable expectations, then there isn't any problem.

Teachers also use student input to design and modify assessments. When an environment has been created where students are given the opportunity to accept responsibility, they do. Sometimes student input goes so far that students accept the responsibility of presenting their opinions, designing their own assessments, and selecting the criteria for grading.

> Yes, it was part of the points. And all of the points, the whole thing, what we were going to grade on, was discussed with the kids before it ever started. They decided on the criteria. This is what they wanted to find out.

Teachers listen to the student voice in this assessment environment (Brooks & Brooks, 1993; Stiggins, 1985; Tittle, Hecht & Moore, 1993) . They engage and present highly valued, student directed formative and summative assessments (Angelo & Cross, 1993; Geocaris, 1997) .

Teachers use questioning strategies to assess student prior knowledge (Penick, Crow & Bonnstetter, 1996) . Response to questions can reveal what students already know and what their beliefs are (Brooks & Brooks, 1993; Driver & Oldham, 1984; Jeffryes, 1994; Magoon, 1977) .

> It was just like four essay questions, this one was, or short answer but it was based more on their belief system and really a search of what they knew coming in.

Teachers incorporate knowledge of a larger picture, of big ideas, into assessment and instruction (NSES, 1996). SS&C Tenet #5 is the commitment to begin with larger ideas and themes (Yager, 1993) .

> Kids are used to be doing like, this animal is a mammal, this ones a reptile or something like that but it [the assessment] asks them to look at larger systems and cycles and how animals and habitat are interdependent on each other and also how man affects that.

Teachers use a variety of inquiries. Inquiry is the heart of the content standards in the NSES (1996). Using inquiry helps increase scientific understanding and reasoning (NSES, 1996). Inquiry is central to an understanding of the nature of science (Bentley & Garrison, 1991) . SS&C Tenet 6 states the commitment to encouraging new student experiences based on inquiry (Yager, 1993) . Inquiries include those that are examples of: the strength of observations, how to accommodate new knowledge into a larger picture, and how results are validated.

> And they would test and modify, test and modify, test and modify. Steal from each other, learn to watch what other people do, build upon that. So the idea, again, was to learn more about how science operates, for them to be able to do a different type of an inquiry. With each inquiry due, there's a different set of expectations which means they have to be more consistent with what the nature of science would be like.

Defining the Environment Through Student Engagement

Students have an active role in STS/Constructivist classrooms because their minds are engaged. They are not empty vessels sitting politely in rows in silence. Students question themselves, their peers, and their teachers on the new knowledge they are trying to incorporate into their mental structures (Osborne & Wittrock, 1983) .

Iowa SS&C teachers encourage student involvement in the assessment environment in a variety of ways. Four are described here: (a) teachers involve students in decision making, (b) teachers enroll students in directing their own assessments and learning, (c) teachers engage students by using relevant issues, and (d) teachers motivate students by using a variety of assessments. Student involvement is essential in STS/Constructivist classrooms. The more they are involved the stronger voice they have (Angelo & Cross, 1993; Brooks & Brooks, 1993) .

Students are involved in the decision making process of what makes up the assessments used to give them a grade. Sometimes their involvement is direct, and sometimes it is indirect.

> Every time that I come up with something, I'll always ask kids and say does this make sense and does this. And I think they're some of the best judges because they're involved in the process. I'll say, is this a good question and I usually test it out on, I'll pick some students out in the study hall setting and I say, read this and tell me what you think.

> Students are enrolled in directing their own assessments and consequently the learning that goes along.

> I'm getting more comfortable with them being able to show me in different ways that they've gotten it. That's still hard, is letting them be able to pick the vehicle and then all I have to do is respond to the criteria. They struggle with it too, they're not used to it.

Student engagement is another important area where students' interaction with content can be gauged (Geocaris, 1997) . Students are actively engaged in learning in constructivist assessment environments because learning has personal relevance for them (Yager & Tamir, 1993) . This happens because the teacher knows what is relevant and/or uses local issues to draw students into the learning process (Yager, 1993) . Issues emerge from student brainstorming that is guided by teacher "savvy."

Finally, teachers report that students are intrinsically motivated by different kinds of assessments, ones that are or are a combination of: (a) goal or product oriented, (b) student self-directed, or (c) entertaining.

> The one that motivates them the most I think, without any doubt, is the visual one where they can perform. That there's a performance component. Where they know that what the expectations are, first of all to start with. And the second piece is that they have ownership of it.... It's more open-ended, they're motivated by their own questions much more so than they're motivated by my questions.
>
> I would probably have to say that the trials at the beginning were probably the most. I don't know if it's because the kids are still fresh and they haven't realized that they're learning anything yet. They still think it's fun. But I also liked it because it gave those kids that were good at writing a chance. It gave those kids that were good at speaking a chance and it gave those kids that really weren't sure what they were good at yet, a chance to just kind of get started.

Something else that emerges in motivating practices is that all of the assessments mentioned involve group work. Students enjoy the social aspects of collaboration. Teacher practices support assessments that are highly valued and that are directed by teachers and students (NSES, 1996). The assessment environment is one where there is active learning in a social context (Cobb, 1994; Magoon, 1977) . Assessment is not an after thought but a respected component of the classroom environment (Tamir, 1993) .

Influences on the Assessment Environment

The assessment environment is influenced internally and externally. Internal influences include the daily interactions of the students and teachers within the context of classroom instruction. External influences came from district, state, or other educational sources.

The constant internal influence on the assessment environment is the teacher's curiosity and the need to find a solution to the statement, "there's got to be a better way." Teachers report that networking with other teachers and professionals is a source of new ideas (Fullan, 1996) . Teachers enjoy "kicking around ideas" with others and working as a team which is one consistent element of the Iowa SS&C project (Yager, Liu & Varrella, 1993) . Networking is a major source of ongoing change (Fullan & Hargreaves, 1991; Trax, 1997) . Interactions with others and intrinsic motivation leads teachers on a journey of change. Motivating factors for change focus on never being satisfied with the status quo. Iowa SS&C teachers seek new methods that will help them improve their teaching and assessment practices; the search for new ideas from educational research because they are life-long learners. They seek information from a variety of places. Here is a list gleaned from the teacher interviews: workshops, courses, magazines, conferences, study groups, mentors, professors, discussions, their own children, feedback from students, the cooperating teacher/student teacher relationship, Chautauqua, SS&C, colleagues, NSTA, IST, university funded programs, studying constructivism and the nature of science.

External influences on the classroom assessment environment can come from two sources. First is externally designed assessments that come from test-banks or as resource material that accompanies textbooks. Some teachers are required to use the text and the tests that come with them. Externally constructed national standardized tests are not usually relevant to students everyday learning (NSES, 1996). Consequently their use is often forced (NSES, 1996).

A second form of external influence is the *coverage* issue. Pressure is applied from a variety of sources, e.g., state mandates, district tests, parents, or the school board. The teacher is compelled to cover the material. Coverage acts in a similar manner as standardized tests. It reduces the scope of the curriculum and can focus on LOTS instead of HOTS (Darling-Hammond, 1993; Latchaw, 1995) .

A Variety of Assessments

A second theme that emerged from the interview data is that teachers use a variety of assessments to make up a student's grade. Variety in this case does not mean sheer numbers. Variety means that different kinds of items make up assessments (Brooks & Brooks, 1993; Shepard, 1989; Stiggins, Frisbie & Griswold, 1989; Wiggins, 1997) . This assumes that the teacher is aware of how students learn best and that the teacher wants students to grow in competence in a variety of learning situations (Brownstein, 1996; Caine & Caine, 1991; Gardner & Boix-Mansilla, 1994) . Students are given multiple opportunities to show their competence and have opportunities to gain experience in styles where they are not so competent. Variety means visual, performing, writing, talking, designing, and presenting knowledge as individuals and in groups (Champagne & Newell, 1992) . Variety also means that grades are a profile of many areas of competence that may include: concepts, inquiry, application, creativity, attitude, and a world view (Yager & McCormack, 1989) . Effort that reflects engagement, motivation, and ultimately attitude expands variety beyond achievement. Assessments are characterized by being different. Variety according to interviewees includes: demonstrations, explanations, write a script, cartoons, draw a food web, inquiry, observations, use a rubric, make a checklist, drawings, immune skits, concept maps, role play a situation, projects,

collage, logbook, review sheet, explorations, experiments, summaries, uses for new technology after viewing a video, presentations, outlines, and scale drawings.

Variety includes application, a specific type of assessment of knowledge, that is an essential element of STS approach and the Constructivist Learning Model (Harms & Yager, 1981; Yager, 1991) . Students must make extra effort in order to complete the conceptual change process. Application assessments have four elements: (a) HOTS levels are used (Yager & McCormack, 1989) , (b) content is well structured (NSES, 1996), (c) uses exhibitions of student knowledge (Brooks & Brooks, 1993) , and (d) involves problem solving (Yager, 1993) .

Variety includes different social configurations for assessments. Students like to work in groups. They enjoy the interaction. Additional avenues of assessment become available when students work in groups. During group work students usually accept responsibility and are engaged (Geocaris, 1997) . Group work is an essential principle of social constructivist theory (Cobb, 1994; Cobb, Yackel & Wood, 1992) . Some of the options include peer evaluation and making use of the cooperative or collaborative intellect.

> Well, it looked like chaos. There was a lot of discussion going on. There were groups on the floor, there were groups at desks, they were just all over the room but there was excitement. You could feel the excitement.
>
> But what they did was devise ways to be able to classify the soil. They had to work in groups and come to a consensus of how they could interpret or look or observe soil and make varying things.

Higher Order Thinking Skills (HOTS) in Assessment

The third theme that is relevant to this study is the use of higher order thinking skills in all aspects of assessment and learning. Going beyond recall and on to application, comparison, analysis, and evaluation (Burry-Stock & Cochran, 1996) , is essential if students are going to accommodate information into new mental structures (Hewson & Hewson, 1988; Osborne & Wittrock, 1983) . HOTS is incorporated into three of the eight SS&C Tenets, i.e., "focus on comprehension of science concepts, explain and apply science in personally meaningful ways, and work toward quality of thought," (Yager, 1993) .

When HOTS are an integral part of instruction/assessment, two additional assessment formats become available, relating assessment to real-world phenomenon, and the ability to use a broader variety of assessments (Brooks & Brooks, 1993) .

> This is a Copernican model that they drew... we used it a lot, for a lot of different labs and then to explain a lot of different things. We used it to explain not only Copernicus's theories about heliocentric universe, or heliocentric solar system but we also used it to explain the retro grade motion of Mars, and we used it to explain the seasons of the year. ...we looked at the constellations that were visible on the plain of the elliptic so we took a look at those and why they were there and then we were able to use those constellations to help us with the seasons of the year, that helped a lot because we could talk about, ...[what] constellations would be visible, you know, if this were summer this is where the constellations were. On the other side of the sun during summer you would be able to see...why.

When HOTS are evident, content becomes a vehicle for students to show understanding of HOTS (NSES, 1996).

> [Students role play a team of doctors whose task it is to identify a muscular disorder and present it to the family of the patient.] They have to diagnose it, there is no diagnosis there, they have to figure out what it is. And again, you have to get problems that are figure-outable by a high school kid at this point. That's the tough part. You want at least 12 or 13 of them so that if they work in pairs, everybody has a different one. To find 12 that aren't rare muscular diseases in some obscure medical text that these kids can find is not easy. They keep a work log, they have to come up with a visual.

When HOTS are evident, it opens the door to exciting inquiries. Inquiries where there are: solution, information acquisitions, and more questions (Yager, 1991) .

> I do have one student-designed experiment in there whether doing it - you can call it product testing if you want - where they're trying to determine the effectiveness of various mouth washes.

Inquiry with HOTS also leads to the processing of information. Once again a vital component of the conceptual change process (Osborne & Wittrock, 1983) .

> And then from there we brainstorm and we come up with a list of characteristics as to what does make up a good source and what are you looking for when you go research things for science. And this is the very first thing we do, this is day one. Because when they go and do their projects and things, they always ask themselves those questions.

Students working in groups learn and apply HOTS process knowledge to create team assessments. These assessments include projects, presentations, and performances. Group work allows student to exercise their strengths and receive support for their weaknesses. Often the knowledge gained is more than expected of an individual.

> On geological history....everybody researched Iowa's geological history and created their own mural. And they could do it anyway they wanted....Some did it really long, some did it in circle graphs, they were able to do it circle graphs, you know, where it's a pie chart. And they had to learn angles. These kids had never studied angles so they learned the circumferences of a circle and they learned how many degrees were in a circle. So they got a lot more out of that than just the geological that went ------ a lot of math went into that one.

HOTS are an integral element of each of the NSES changing views of assessment (NSES, 1996, p.100). They are discussed as a missing component of assessment in the issues of *teaching to the test* and *grading practices* (Latchaw, 1995; Stiggins & Bridgeford, 1985) . HOTS are needed for conceptual change (Osborne & Wittrock, 1983) . HOTS are integrated into frameworks, modules, and everyday lessons by the participants in the Iowa SS&C project (Yager, 1993; Yager et al., 1993) .

Implications

Philosophy, pedagogy, and teacher practices combined to affect the nature of assessment used in classrooms of participants in this study. The main results were:

1. The assessment environment can be described by teachers.
2. A variety of assessments are used to determine a student's grade.
3. Higher order thinking skills are an integral part of Iowa SS&C teacher assessment items.

The assessment environment is a complicated dynamic place. Iowa SS&C teachers who were a part of this study described an assessment environment that is viable and conforms to the NSES, constructivist theory, and STS pedagogy. Iowa SS&C teachers receiving reform information and integrating it into their classroom assessment environment are different from those who are not involved in the reform movement. The existence of this kind of environment should be shared. Implications for pre-service teaching and professional development include:

1. Iowa SS&C teachers should discuss their assessment practices with other teachers as a means of informing others as well as a means of gaining new ideas themselves.
2. Other teachers should observe Iowa SS&C teachers classrooms.
3. Assessments used in Iowa SS&C classrooms should be shared, along with the instruction that surrounds assessment items.

Variety in assessment is more than a list of items as designated by the ACLSI. It is defined in depth by teacher practices noted from the interviews, including: addressing multiple learning styles, variety in semester and week projects, variety in thinking skills, and variety in inquiries. Implications for pre-service teaching and professional development include:

1. Multiple learning styles need to be explored in pre-service teaching courses.
2. A deeper exploration of different items needs to be developed (more than just listing possibilities).
3. Explanations of purpose need to be addressed.

Assessments that include higher order thinking skills represent one type of this variety. Implications for pre-service teaching and professional development include:

1. Course material should include suggestions for teacher development and specific identification of HOTS for assessment purposes.
2. Students should be given more time to think about the science they are doing.

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